Search for two-phonon octupole vibrational states in ^{208}Pb

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Following our previous suggestions [1] we performed an experiment to investigate the two-phonon octupole vibration in ^{208}Pb at a bombarding energy below the Coulomb barrier to only allow Coulomb excitation. In our first experiment, using a bombarding energy 20% above the barrier we have neither been able to identify any candidate of the expected two-phonon states nor to extract sensitive limits for the population of these states. To obtain at least sensitive limits for the existence of the two-phonon states we have now performed an experiment using Gammasphere and a ^{136}Xe beam of 650 MeV (E/V$_C$=0.9) on a thin (0.6mg/cm^2) ^{208}Pb target. Besides obtaining sensitive limits the Coulomb excitation mechanism enables also to measure E3 moments of excited states which is a crucial parameter for measuring the harmonicity of the vibration. The newly constructed two-dimensional position sensitive parallel plate avalanche counter CHICO was used for this purpose and also to correct for the Doppler-shift of the in flight emitted γ-rays. Although the bombarding has been chosen to be higher than the "safe" energy we expected the closest distance for forward scattering still to be big enough to exclude nuclear interaction. The observed angular distribution of the excitation probability as a function of the scattering angle justified this approach. The higher bombarding energy is necessary to enhance the excitation probability of states populated by steps of about 2.5 MeV.

As before we have not been able to observe any state close to the "harmonic" energy of about 5.2 MeV. However, this time we have been able to extract sensitive limits on the E3 matrix-element of a 6^+ state at this energy. Taking into account the background of the measured γ-spectra and results of Coulomb excitation calculations we can exclude a 6^+ state at 5.2 MeV with a E3-strength larger than 15% of the expected harmonic value. Furthermore, we have been able to determine the E3 matrix-element for the lowest 6^+ state at 4.42 MeV. It turns out that we observe about 20% of the total "harmonic" strength in this state already. Although we also observed the γ-decay the lowest 4^+ state at 4.32 MeV as indicated in fig. 1 we have not been able to extract the E2 or the E3 matrix-element. This is due to the fact that the 4^+ state can be excited over two competing pathways: either two E2-steps ($0^+ \rightarrow 2^+ \rightarrow 4^+$) or two E3 steps ($0^+ \rightarrow 3^- \rightarrow 4^+$).

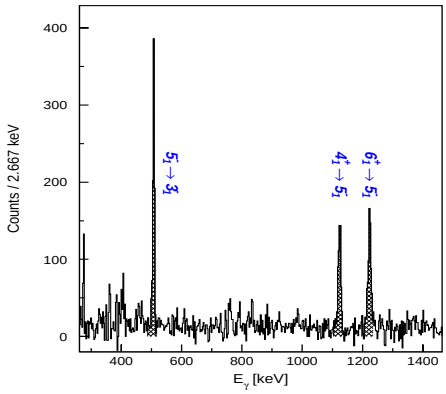

Figure 1: Partial γ-energy spectrum of ^{208}Pb after gating on the $3^- \rightarrow 0^+$ transition at 2614 keV.

References

[1] K. Vetter *et al.*, Phys. Rev. C. **56**, 2316 (1997).